

Re-Turning the Tide: Restoring Tidal Flow to Outer Cape Estuaries

Cape Cod National Seashore
Natural Resource Management Staff

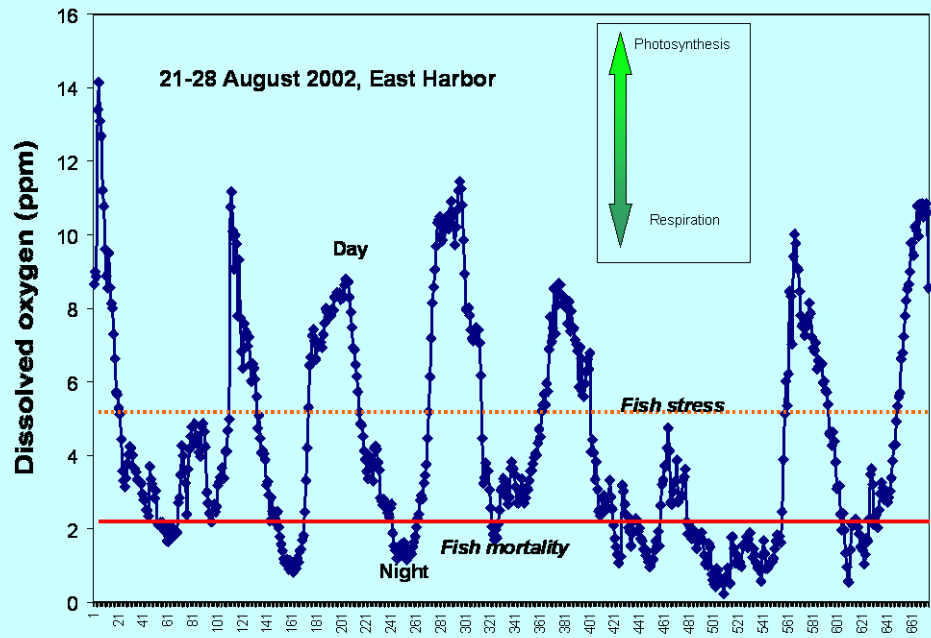


Cape Cod National Seashore, in cooperation with the outer Cape towns of Provincetown, Truro, Wellfleet and Eastham, Massachusetts Coastal Zone Management, and other state and federal agencies, has been working to restore some of the 2500 acres of salt marsh estuaries that have been cut off from the sea by roads, railways and dikes. Over the last few years major progress has been made in returning not only tides, but also salt marsh plants and animals to Hatches Harbor in Provincetown and East Harbor (Pilgrim Lake) in Truro.



Estuaries like East Harbor in Truro (including Pilgrim Lake, Moon Pond and Salt Meadow) and Hatches Harbor in Provincetown have been radically altered over the past century by development that has partially or totally blocked their vital connection with the ocean.

Tide restrictions damage estuarine systems



Cutting off tidal flushing to organic-rich salt marshes causes dissolved oxygen to fluctuate wildly over the day-night cycle. Before tides were partially restored, East Harbor showed frequent overnight oxygen depletions and fish kills during the summer months.

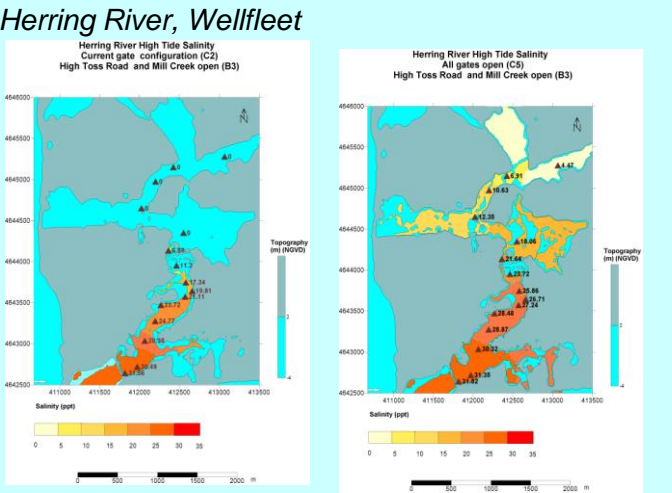


Oxygen stress and the loss of predatory fish, in turn favored the production of chironomid midges, which were a huge nuisance to local residents and visitors to the Pilgrim Lake and Beach Point community.



Tide restrictions allow exotic organisms, like common reed, to crowd out productive salt marsh grasses (left); they also allow introduced animals, like this carp (right), to proliferate at the expense of both native fish, seagrasses and water quality.

Several decades of scientific research have shown that historically restricted estuaries can be restored, and their values to both salt marsh organisms and coastal communities re-established, by careful re-introduction of the tides.



An early step in tide restoration is to collect tide height and topographic data to build a computer hydrodynamic model of the system. The virtual dike in the computer model can then be "opened" and the model will predict upstream tide heights and salinities. The above diagram shows the computer-predicted effects of opening the Herring River (Wellfleet) dike on salinity of the upstream diked wetlands.

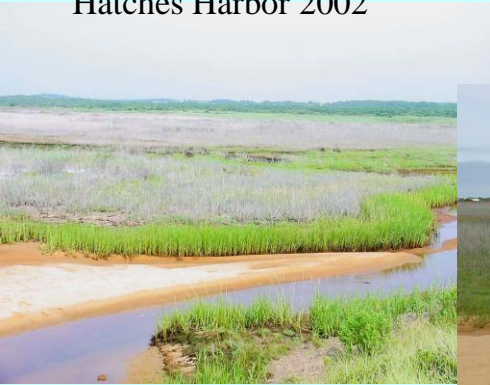


The environmental effects of the 1909 diking of Wellfleet's 1100-acre Herring River flood plain have been extensively studied, and tidal restoration alternatives have been modeled.



Based on modeling, culverts can be appropriately sized and positioned in dikes to allow the restoration of tides, salinity and estuarine plants and animals while protecting any sensitive structures within the coastal flood plain. Adjustable culverts, as shown above in the Hatches Harbor Dike, have been opened gradually, giving time for the re-establishment of salt marsh plants and increased sedimentation.

Hatches Harbor 2002



Hatches Harbor, Provincetown



As tidal flooding and salinity are restored on the Hatches Harbor marsh, native salt marsh grasses (above photo, right) are replacing salt-killed shrubs and herbs (left) which had invaded since the dike was built in 1930.

Hatches Harbor 2004



East Harbor, Truro & Provincetown



With restored salinity, and the removal of exotic grazing carp (left inset), seagrasses like *Ruppia* and eelgrass have proliferated in East Harbor, providing food and cover for thousands of estuarine fish and shrimp.



Setting of softshell clams (above), hard clams and mussels, and their rapid growth, has followed the partial restoration of tidal flow and salinity in East Harbor (Pilgrim Lake).



Native silversides, mummichogs and sticklebacks are now abundant small "bait" fish in Pilgrim lake. Although the lake is still eutrophic (rich in algae), there have been no oxygen depletions or fish kills since the culvert was opened.

Pilgrim Lake fauna	Before restoration	After restoration
Mummichog		X
Atlantic silverside		X
White perch	X	X
Winter flounder		X
Hogchoker		X
Pipe fish		X
American eel	X	X
Sand shrimp		X
Shore shrimp		X
Green crab		X
Nine-spine stickleback		X
Four-spine stickleback		X
River herring (<i>Alosa</i> spp.)	X	X
Sand eel		X
Common carp	X	X
Soft-shell clam		X
Hard clam		X
Blue mussel		X

Conclusions:

Ongoing tidal restoration at East and Hatches Harbors has shown that even moderate increases in tidal range and salinity can result in the suppression of exotic species, and the re-establishment of salt marsh plants and aquatic animals in just a few years, and over hundreds of acres of historically tide-restricted estuaries.